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**Participation by Land Operations Division Personnel at  
the Soldier Survivability and Personal Protection Seminar  
and at Meetings with Defence Science and Technology  
Laboratory, United Kingdom December 2009**

*Leanne Rees and Paul Dabinet*

**Land Operations Division**

Defence Science and Technology Organisation

DSTO-GD-0614

**ABSTRACT**

Mrs Leanne Rees and WO2 Paul Dabinet visited the United Kingdom in December 2009 to attend the Soldier Survivability and Personal Protection 2009 Seminar (SSPP) and meet with Defence Science and Technology Laboratory, Land Battlespace Division. This enabled Land Operations Division to further develop its understanding of Soldier Protection, Load Carriage and Survivability through engagement with the international community.

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# Participation by Land Operations Division Personnel at the Soldier Survivability and Personal Protection Seminar and at Meetings with Defence Science and Technology Laboratory, United Kingdom December 2009

## Executive Summary

Soldier Modernisation Task in Land Operations Division (LOD), Defence Science and Technology Organisation (DSTO), is currently undertaking a series of research activities aimed at developing an Operational Evaluation Framework for assessing the operational capability and impact on soldier equipment and personal protection. A key consideration in this research is the protection/mobility/lethality trade-off space in reducing the soldier's burden.

Mrs Leanne Rees (senior operations analyst) and WO2 Paul Dabinet (LOD Military Staff) attended the Soldier Survivability and Personal Protection 2009 Seminar (SSPP) and met with Defence Science and Technology Laboratory (Dstl) Land Battlespace Division in the UK in December 2009. The information from these activities was used to further develop LOD's understanding of Soldier Protection, Load Carriage and Survivability through engagement with the international community.

The seminar and visit to Dstl provided international forums to inform analysis methods used for determining requirements, and considerations associated with the employment of Personal Protective Equipment (PPE) and Load Carriage Equipment (LCE) on the individual dismounted soldier.

Following the meetings with Dstl a bilateral agreement has been established with DSTO for and exchange of soldier modernisation data and methods.

# Authors

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# Contents

## ABBREVIATIONS

<b>1. INTRODUCTION.....</b>	<b>5</b>
<b>1.1 Aims and Objectives .....</b>	<b>5</b>
<b>2. METHOD.....</b>	<b>6</b>
<b>3. VISIT OUTCOMES .....</b>	<b>6</b>
<b>3.1 Phase One – Dstl Discussions .....</b>	<b>6</b>
3.1.1 Outcomes from Dstl Discussions .....	7
<b>3.2 Phase Two – Attendance at the Soldier Survivability and Personal         Protection Seminar .....</b>	<b>8</b>
3.2.1 SSPP Workshop .....	8
3.2.2 SSPP Conference.....	8
<b>3.3 Summary of Benefits from Conference Attendance .....</b>	<b>10</b>
<b>4. SUMMARY AND CONCLUSIONS.....</b>	<b>12</b>
<b>5. FUTURE WORK.....</b>	<b>13</b>

## **Abbreviations**

CAEn	Close Action Environment
Dstl	Defence Science and Technology Laboratories
DSTO	Defence Science and Technology Organisation
ECM	Electronic Counter Measure Equipment
IED	Improvised Explosive Device
IWARS	Infantry Warrior Simulation
LOD	Land Operations Division
LWDC	Land Warfare Development Centre
NATO	North Atlantic Treaty Organisation
OEF	Operational Evaluation Framework
PPE	Personal Protection Equipment
SME	Subject Matter Expert
SSDM	Sustainability Systems Dynamic Modelling
SSPP	Soldier Survivability and Personnel Protection Seminar
TTCP	The Technical Cooperation Program
UK	United Kingdom

# 1. Introduction

Land Operations Division (LOD) at the Defence Science and Technology Organisation (DSTO) is currently undertaking a series of research activities aimed at developing an Operational Evaluation Framework (OEF) for assessing the operational capability and impact on soldier equipment and personal protection. A key consideration in this research is the protection/mobility/lethality trade-off space in order to mitigate issues including system weight and balance.

Mrs Leanne Rees and WO2 Paul Dabinet represented DSTO at the Soldier Survivability and Personnel Protection (SSPP) Seminar held in the United Kingdom (UK) in December 2009. Additionally, through the Technical Cooperation Program (TTCP), a series of discussions was held with Defence Science and Technology Laboratory (Dstl) Land Battlespace Division.

Attendance at the seminar and the visit to Dstl were identified and established through Project Land 125 tasking requirements and in conjunction the Land Warfare Development Centre (LWDC) considerations.

## 1.1 Aims and Objectives

A two-member team from the Soldier Modernisation Project, consisting of a military representative and a senior operations analyst, was considered appropriate to represent DSTO at both the SSPP seminar and the Dstl visit. This enabled the application of scientific approaches and military practices.

The aim of participation in the activities was to gather information on soldier survivability in relation to the trade-off between mobility and protection of the dismounted combatant, specifically looking to:

- obtain information to inform the soldier modernisation comparison of capability options evaluation framework;
- obtain information relating to the methods of evaluating soldier survivability on the battlefield;
- gather information associated with evolving technology enhancements in soldier protection;
- gain an understanding of international participants' approaches to soldier modernisation;
- better understand the integration of sub-systems associated with load carriage and personal protection equipment (PPE);
- learn about new developments to enhance Survivability on the battlefield; and
- be aware of advancements in trauma treatment to increase casualty survivability.

## **2. Method**

The objectives of the overseas visit were achieved through the visit to Dstl (Fort Halstead, 4 to 7 December 2009) and attendance at the SSPP seminar (London, 8 to 10 December 2009). Together these activities provided information relating to the technical and scientific aspects (from Dstl) and an international perspective (from the seminar) of issues associated with soldier burden.

## **3. Visit Outcomes**

Reporting of the visit outcomes is broken into two phases:

- Phase 1 - visit to Dstl
- Phase 2 - attendance at the SSPP seminar

### **3.1 Phase One – Dstl Discussions**

The aim of the visit to Dstl was to exchange methods for validating frameworks associated with the evaluation of the soldier system and the performance associated with the trade-off in mobility and protection. The visit also provided opportunities for collaboration through TTCP alliances.

Discussions were held with personnel from the Land Battlespace Systems Division of Dstl and included technical and analysis group heads.

Dstl personnel included:

- Dr George Brander
- Dr Nick Stainbridge (Capability Advisor and Team Leader)
- Dr Graham Sanger (Head - Principal Systems (Technical Lead))
- Dr Martin Reed (Head – Principal Analysis (Analysis Lead))
- Dr Mark Hayes
- Dr Joe Gillard
- Duncan Stewart

These staff provided expertise in the technical and analysis aspects associated with soldier systems studies. The focus was on techniques and analysis processes for assessment, including opportunities for collaboration in the field collection and analysis of data.

Methods of interaction included informal discussion and workshops. The DSTO team (of a military representative and operations analyst) provided a high degree of credibility and quality of interaction with Dstl staff.

Main areas of discussion generated by Dstl included:

- soldier burden framework;
- processes associated with counter improvised explosive device (IED) systems dynamic performance modelling;



- SSDM, (Sustainability Systems Dynamic Modelling) for dismounted soldiers only, and considered as part of pre-combat activities;
- IWARS overview section level best applicability;
- Close Action Environment (CAEN);
- current equipment and PPE;
- survivability assessment; and
- Conspicuity and visual search.

Main areas of discussion generated by DSTO included:

- scoping the focus areas for further discussions;
- discussions for informing capability options, using a soldier modernisation task case study focused on mobility and protection trade-offs; and
- opportunities for future collaboration in data collection and approaches.

### 3.1.1 Outcomes from Dstl Discussions

The visit to Dstl yielded both military and scientific outcomes. The framework presented for the evaluation of soldier performance was readily accepted by Dstl. Conceptual similarity between approaches would readily enable collaboration in this area.

A review of activities undertaken at Dstl highlighted the following points for consideration:

- The opportunity for collaboration between Dstl and DSTO regarding the categorisation of tasks and the collation of information is sought. This will result in standardisation of categorisation, enabling the exchange of relevant data collection opportunities.
- Similarities were observed between the frameworks. Functional decomposition approaches and reliance on the evaluation of individual soldier performance were used to investigate the trade-off in agility and protection. The functional decomposition of tasking occurs, using different approaches. The DSTO model is based on a doctrinal approach incorporating evaluation activities, which are measured through a series of metrics. Dstl use a category decomposition method.
- Key difference between the approaches lie in the method for data gathering methods to evaluate soldier performance. Dstl seeks subject matter expert (SME) input through discussions, whereas DSTO's framework has a more structured and physical measurement bias.
- The DSTO framework provides a single number for comparison on capability options. This approach created some interest with Dstl wanting to compare outcomes.
- Dstl's approach is applied to team considerations, whereas DSTO focuses on the individual dismounted combatant. There may be some differences in the building blocks associated with tasks. However, this will provide useful considerations for DSTO if the framework is extended to a team environment.
- The SME within Dstl, while not necessarily a military person, will have a military background. Unlike DSTO, Dstl is involved with the selection of military personnel to Dstl posts. Dstl has a high proportion of ex-regular military or current territorial personnel as staff.

## 3.2 Phase Two – Attendance at the Soldier Survivability and Personal Protection Seminar

The SSPP Seminar was based on two components: a workshop focusing on lightweight materials and structures for defence; and a two-day conference on soldier survivability and protection. The conference component was the main focus for the DSTO team.

### 3.2.1 SSPP Workshop

The workshop fell far short of expectations. It was lecture-based, focusing on the molecular modelling of body armour materials with little specific relevance other than informing the development of methods for testing polymers behind armour affects, on aspects of science to support modelling rather than testing. While the workshop lacked the structure and specific relevant content, the small number of participants attending afforded the opportunity to make contact with other conference delegates.

### 3.2.2 SSPP Conference

The conference was structured as a series of presentations by keynote speakers followed by questions. Networking opportunities throughout the day allowed for further personal interaction with attendees.

The matrix in **Error! Reference source not found.** lists the presentations and the associated topics that may be relevant to other DSTO tasks. Key focus areas are highlighted specifically for the trade-off task in support of soldier modernisation. The country of origin of the presenting speakers is also indicated. Copies of the majority of presentations are available.

The weights of equipment were discussed. They are comparable to Australian body armour weights. All work to the NATO military standard of overcoming a threat from projectiles at minimum of 500 ms<sup>-1</sup>. Variation appears in the components and the body coverage of the equipment.

Table 1: Summary of presentations and relevance of content

Presentation	Country	Protection	Survivability	Lethality	Agility	Burden on the soldier	Technology	Integration	Injury stats	Modularity	Weight	Ergonomics	Relevance to Specific trade off Task	Other tasks - L125	Other tasks - Vehicles	Cooperation Partner
Integrated Approach to Load Carriage	UK	X			X	X		X		X	X	X	X			X
Lightening the Load	US	X			X	X		X		X	X	X	X			
Human Factors and the Man Machine Interface	Romania	X	X	X	X	X	X	X				X	X	X		
Simulator Requirements and Capability	US		X	X			X	X					X	X	X	
Protection Developments	Finland	X				X	X	X				X	X			
Paving The Way for The Future	Belgium	X	X	X		X	X	X		X			X	X	X	
Counter IED Protective Challenges	US	X	X				X		X					X	X	
Multifunction Designs for Armour	US	X	X	X	X	X				X	X	X	X	X	X	
Nature of Operational Injuries	UK		X	X			X		X			X				
Medical Experiences on Ballistics	Turkey		X	X			X		X			X				X
Mitigation of Blunt Trauma	Canada		X				X	X	X			X		X		
Carbon Nano-tube Applications	UK	X				X	X				X			X	X	X
Signature Management	Sweden	X	X				X	X					X	X	X	X
Explosive Detection	Sweden	X	X				X			X	X		X			X
Ballistic Impact and Fabric Engineering Discussions	UK					X	X	X			X		X			
Discussions	Netherlands	X	X				X	X	X				X	X	X	X
Discussions	Germany	X	X				X	X	X				X	X	X	X

### 3.3 Summary of Benefits from Conference Attendance

A clear thread throughout the SSPP conference was the need to reduce the soldier's burden, without degrading the survivability or lethality of the soldier on the battlefield. It was generally recognised that solving the issue of the individual dismounted combat infantry soldier, as a basis for the investigation, was the fundamental building block for other areas.

The conference highlighted, and accepted, that the main current threat to the soldier's survivability on the battlefield is from IEDs.

In keeping with the central theme of reducing soldier burden, key areas for load reduction included:

- power management;
- batteries size and weight;
- load carriage;
- system weight and bulk;
- battle management systems;
- legacy equipment;
- personal protection equipment;
- electronic equipment;
- ammunition;
- water;
- weapons; and
- weight.

Areas of study to reduce the load include:

- standardisation of systems;
- scalability of system;
- modularity of systems;
- integration between sub systems;
- use of evolving technologies;
- multifunctional materials (intelligent textiles);
- robotics;
- alternative load carriage methods, e.g. mules;
- composite materials;
- trade-off area of protection overage for mobility; and
- comfort.

Adopting a holistic solution to solving the soldier's burden, other considerations associated with survivability and lethality were discussed including:

- using signature management (while a key consideration here was that it is not necessary to have the lowest possible signature, it should be considered as a contrast against the background);
- Electronic Counter Measure Equipment (ECM);
- thermal signature reduction;
- heat management;
- ammunition technologies;

- physiological;
- simulation;
- training proficiency (start with it and use it all the way through);
- camouflage technologies;
- electronic noses for the detection of explosives;
- high performance fibres (e.g. nano tubes);
- medical training and treatment;
- flexibility;
- the need to take the thermal load off the body; and
- Technologies (that are not new):
  - X-ray;
  - Nuclear Quad Resonance;
  - Ion mobility spectroscopy;
  - 'Nose' (explosive detection sniffer);
  - Nano technology;
  - Photonic crystals; and
  - IR Camouflage cream.

Individual soldier performance and the holistic assessment of survivability were considered to be linked to: body armour performance and coverage; the effect on a task; the effect on the platform; and the effect on the mission. These areas align well with LOD's framework, with the exception of the body armour performance and coverage, which is outside the team's current tasking scope.

Soldier survivability and personal protection systems need to be integrated so they work together. Key themes associated with the use of PPE and the soldier as a platform, highlight a systems philosophy and the need for modular integrated systems all linked to reducing the soldier burden. This can be achieved through the reduction of the physical and physiological load on the soldier and by incorporating ergonomic considerations.

PPE options are linked directly to soldier survivability and need to be scalable, modular, and integrated with other systems. Other aspects of protection include consideration of signature management and the incorporation of evolving technologies.

Additionally, survivability of the individual soldier on the battlefield is directly linked to lethality and agility trade-offs. There is an emphasis on lethality and a trade-off in agility for protection. This trade-off is governed by addressing risk through an understanding of the threat. The selection of PPE level is driven by the threat.

A key contributor to the soldier's survivability is that whatever protection option is used it must allow the soldier to complete the assigned mission. In doing this, the soldier must be able to: freely move including movement over ground to afford physical agility; fire a personal weapon, including adopting an appropriate fire position; operate vehicles; put the equipment on and off; and be able to administer first aid. All of which are dependent on equipment weight and bulk, or the level and type of PPE used. This comes with a monetary and casualty cost. A soldier's survivability comes at a cost in terms of money and the number of casualties. To complete a mission, the soldier must be able to assume a tactical posture.

The greatest weight contributors to the soldier's load are:

- weapons;
- ammunition;
- water;
- electronic equipment (power sources);
- batteries; and
- battle management systems.

These contribute to survivability through factors such as signature management, C4I and basic survival.

Information associated with the position and types of injuries experienced by soldiers was provided, with special attention given to IED casualties. Factors, other than the direct effect of blast include:

- burns to the unprotected areas is critical to survival;
- the time of casualty to time of treatment is critical to survival;
- training of medical staff to enhance survival;
- recognising and preventing traumatic brain injury (which has special consideration for helmets);
- reducing behind armour blunt trauma (which has special consideration for body armour); and
- equipment (e.g. magazines) carried externally on the body which can increase injuries.

## **4. Summary and Conclusions**

The trip highlighted the areas of common interest in the evaluation of the survivability of the combatant on the modern battlefield. As a result of discussions and involvement in the presentations, the DSTO team has greater confidence solving the right problem. While approaching at the problem of agility and weight trade-off from different perspectives – discussions with Dstl provided confidence and credibility in the DSTO's framework approach.

Use of the individual soldier as a platform and considering the individual dismounted combatant as the key building blocks for the framework appears consistent with Dstl philosophies.

The conference focused firstly on the systems aspects, and secondly on the tactical situation including technologies and medical issues.

Soldier survivability evaluations need to be conducted with emphasis on a holistic systems approach. In reducing the soldier burden, the main issues include weight bulk, flexibility, modularity and integration.

The team composition of operations analyst and military advisor provided clear credibility during all the activities.

The military member of the team provided:

- tactical, technical and operational context incorporating doctrinal advice;
- a knowledge of military equipment, training implications;
- advice on concepts and terminologies; and
- a link with personnel with military experience.

The operations analyst member of the team provided:

- technical expertise in relevant analytical approaches;
- scientific interpretation of the information provided at the conference;
- interaction with the scientific community; and
- identification and interpretation of scientific issues for consideration as part of current tasking.

## **5. Future work**

Attendance at the SSPP, and discussions with Dstl, allowed DSTO to inform the operational evaluation framework and gain insights into reducing the soldier's burden. Subsequent interpretation of the information gathered through thematic analysis processes yielded a number of key areas for future work and focus for support to the current trade-off in mobility and protection task:

- Opportunities for the collection of data to refine the frequency, likelihood and consequences of the activities and functional task bricks to inform the trade-off analysis framework.
- Opportunities for the collection of data to refine the scaling factors associated with the context to inform the trade off analysis framework.

Data to support these areas can be obtained from:

- Observation of patrol activities in a field environment. Frequency data is collected from observation by an analyst; consequence data is collected by a military observer with an understanding of the activities.
- Workshop with relevant subject matter experts yields the likelihood of occurrence of the activities to a task brick with rating scales. Context information can be obtained in the workshop through data collection sheets.

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Leanne Rees and Paul Dabinet

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